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Factsheet

# COMPARISON OF LIQUID MANURE SPREADING SYSTEMS

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## INTRODUCTION

Handling manure as a liquid is an increasingly popular practice on Ontario farms. The variety of equipment available to do this is sometimes overwhelming. Following is a discussion of the equipment used from the time the manure leaves the storage until it is incorporated into the soil.

There are several characteristics of spreading equipment that should be considered when tailor-making a system for an individual farm:

- cost to own and operate
- capacity
- tendency to compact the soil
- simplicity
- labor requirements
- energy requirements
- nutrient losses possible
- timing of spreading (convenience)
- time needed for set-up
- effect of distance to field
- uniformity of spreading
- limitations due to topography or field shape
- ease of maintenance
- possible contribution to air pollution (odors)

The following systems summarize what Ontario farmers are now using and will likely be using in the near future.

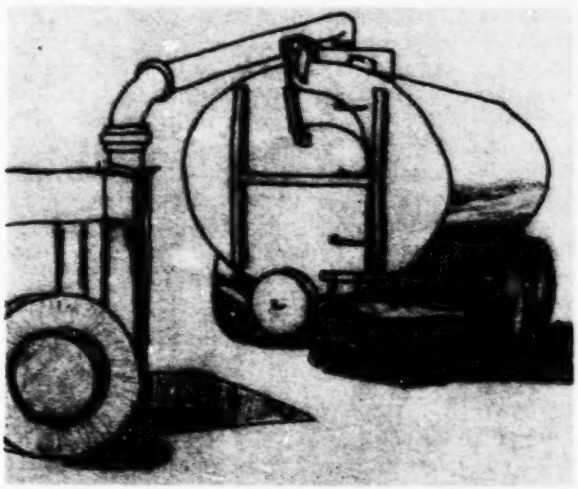

**Figure 1.** Top-loading tank spreader being filled.

## TANK SPREADERS

The most common way to spread manure on Ontario farms is with tank spreaders. The tanks are usually trailer-mounted and pulled by a tractor. Capacities vary, but tend to be less than about 17000 litres (3800 gal.) The tanks are filled at the manure storage, hauled to the field and used to distribute the manure on the field.

### Advantages

- about the most cost effective system on medium-sized livestock farms
- relatively simple
- flexible in terms of actual spreading method

### Disadvantages

- high energy requirements to haul spreaders
- soil compaction can be a serious problem
- travel time can be high when fields are distant

There are basically two styles of tank spreaders: (1) the top-loading; and (2) the vacuum tank spreaders. Top-loading spreaders are filled through an opening in the tank top. Pumps are generally used to fill these spreaders, although gravity loading is sometimes feasible.

### Advantages

- cheaper than vacuum tank spreaders
- faster loading is possible
- simpler system than vacuum tank spreaders

### Disadvantages

- pump is needed to fill spreader

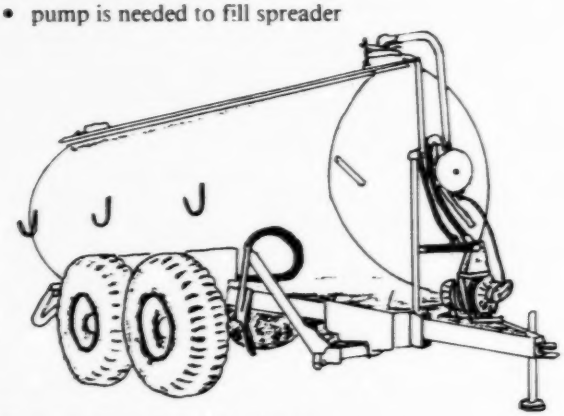

**Figure 2.** Vacuum tank spreader

Vacuum tank spreaders rely on an air pump to change the air pressure inside the sealed tank. A partial vacuum can be created to suck manure in through a large diameter hose. When a positive pressure is created, the manure is forced out, either to agitate the storage or to be distributed on the land.

**Advantages**

- relatively clean spreaders - less chance of spilling manure when loading
- pump needs less maintenance than regular manure pumps - it only pumps air
- large suction hose permits large solids to pass
- some storages can be unloaded only with a vacuum line

**Disadvantages**

- agitation potential is limited to small storages or those holding easily agitated manure
- turnaround time per load is increased when spreader is used to agitate storage
- higher cost than top-loading spreaders
- hook-up of the suction line for each load is a disagreeable chore

Both of these spreader systems offer options in the actual method of field distribution. The choice is between broadcasting and injecting.

**Broadcast systems** employ some means of shooting the manure out in a wide spread pattern. Usually, either an impeller or high air pressure in the spreader forces the manure against a deflector plate which creates the spread pattern. This pattern may be out to one side of the spreader, originating at either end of the spreader. Alternatively the pattern may originate at the rear and extend an equal distance on each side of the line of travel.

**Advantages**

- less cost than injectors
- simple
- less power needed than for injector systems

**Disadvantages**

- more odor than with injectors
- uniform application is difficult during gusty or very windy conditions
- manure nutrients are eaily lost if manure is not immediately worked into soil

**Injection systems** have gained in popularity as farmers have become more concerned about nutrient retention and odor control during spreading. Injectors consist of cultivator teeth, or shoes on rigid shanks. These open up the soil enabling manure to be deposited below the soil surface. The injectors may be mounted on the tractor's 3-point-hitch or they may be attached to a tool bar at either the front or rear of the spreader. When mounted in front of the spreader, the driver can see them better and depth control is easier, especially on rolling land. Rear mounted injectors can have the advantage of breaking up the soil in the wheel tracks.

**Advantages**

- odor control during spreading
- maximum nutrient retention
- when used in standing row crops, nutrients are deposited closer to plant root zone

**Disadvantages**

- more power needed to pull injectors through soil
- greater cost than broadcast systems
- may be limitations in stony soil
- can cause erosion on long slopes with row crops
- injection into sod can be difficult

## IRRIGATION SYSTEMS

In the past few years, irrigation of manure has been steadily gaining in popularity. Equipment that was originally designed to handle only water has been effectively modified to deal with the special problems of handling liquid manure. Manure is pumped from the storage to the irrigation gun or sprinkler head. Pumping distances can be great, but to pump more than about 800 metres (2600 ft.) will often require a booster pump. The ease of pumping is highly dependent on the consistency of the manure. The dry matter content should be 4% or less for best results. Basically, two types of irrigation systems are used to spread manure: (1) the travelling gun system; and (2) the hand-portable system.

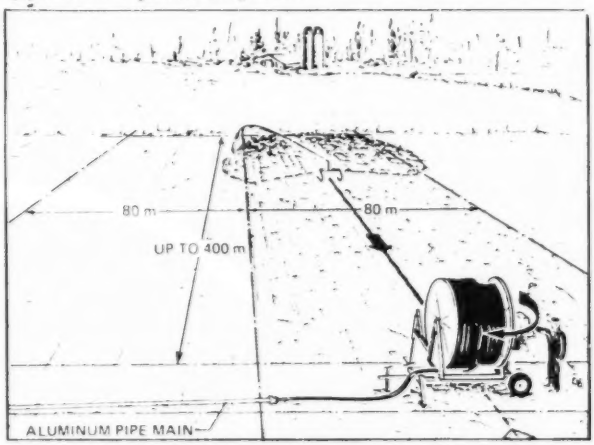


**Figure 3.** Hard hose, travelling-gun irrigation system.

**Travelling gun systems** may be of either the "hard hose" or "soft hose" types. In both cases, manure is pumped from the storage through rigid irrigation pipe (usually aluminum) to a certain point in the field. Both types also involve an irrigation gun that slowly travels across the field, spreading manure behind it in a semi-circular pattern as it moves forward. The hard hose system makes use of a stiff plastic hose which slowly winds up on a large reel, thus pulling the travelling gun across the field. The soft hose system is generally a less expensive alternative. The flexible hose conveys manure to the gun, but it simply drags behind as the gun moves. A steel cable extending to a rotating drum at the end of the run pulls the traveller across the field.

**Advantages**

- very little soil compaction
- less energy needed than the tank spreader systems
- equipment may be used to irrigate water on crops during dry periods

- faster spreading rates possible than with tank spreaders, especially as distance from storage increases
- as long as system is being constantly watched, operator may perform other jobs nearby

**Disadvantages**

- high initial cost - especially for hard hose traveller systems
- distance to field may be a limitation
- uniform application is nearly impossible during gusty or very windy conditions
- odor levels can be high
- manure nutrients are easily lost if manure is not immediately worked into the soil
- manure should be dilute (4% solids or less)

**Hand-portable systems** make use of a main line with laterals. Sprinklers are moved from one hydrant to another and left for a period of time. In order to cover the circular area as uniformly as possible the sprinkler must break up the stream of manure much more than for the travelling gun systems. This leads to smaller particles and therefore, more odors and higher nutrient losses during spreading.

**Advantages**

- lower cost than other irrigation systems
- relatively simple operation
- low energy requirements
- no soil compaction

**Disadvantages**

- odor level (and nutrient loss) can be high
- very difficult to achieve uniform application of manure
- changing sprinkler heads is a messy job
- over-application due to neglect is a common problem with this system

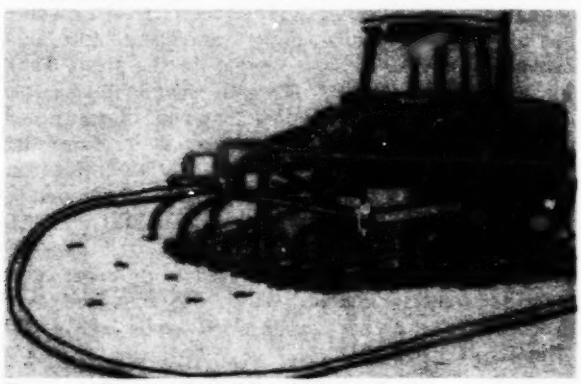

**Figure 4.** Tractor-pulled flexible hose for injecting manure into the soil.

## TRACTOR-PULLED FLEXIBLE HOSE

A system relatively new to Ontairo consists of a long flexible hose pulled by a tractor. Manure is pumped from the storage through rigid irrigation pipe to one end of the flexible hose. At the other end of the line is either an injector or a broadcast nozzle mounted on the 3-point-hitch of a tractor. The tractor starts next to the main pipe and by travelling back and forth, while dragging the flexible hose behind, spreads manure over a fairly large area. Using a flexible hose with a length of 200 metres an area of about 5 hectares can be covered without having to move the main line (2-1/2 ha. on each side of the main line). The hose is a very tough fibre-reinforced plastic similar to that used for the soft-hose traveller irrigation systems.

**Advantages**

- much less tractor power needed than for tank spreaders
- high rates of spreading are possible (volume spread per hour)
- less soil compaction than with tank spreaders

**Disadvantages**

- manure can't be spread on standing crops
- fields with obstacles such as trees pose special problems
- distance to field may be a limitation (similar to irrigation systems)
- manure should be fairly dilute (4% solids or less)

## TRACTOR-PULLED FLEXIBLE HOSE WITH INJECTION

The version which equipment dealers are promoting in Ontario consists of an injector mounted on the tractor. Instead of pulling a tank spreader, the tractor only has to drag the flexible hose. Although the draft is much less, it increases as the distance out from the main line increases. Various designs of injector may be used but some method is needed to attach the flexible hose, preferably as low as possible. At the end of a run, the injector is lifted out of the soil. Manure continues to pump through the drop nozzles as the tractor turns. A special rigid swinging pipe on the equipment prevents the hose from being pinched or run over by the tractor tires while turning. The injector is then lowered into the soil and the next pass begins. If problems develop, it's advantageous for the driver to have some method (such as a radio) to signal the person monitoring the pump at the storage. In the United States, remote controlled pumps are used by some operators.

**Advantages**

- odor control during spreading
- maximum nutrient retention
- less power needed than with tanker-injection systems
- relatively simple operation

**Disadvantages**

- some manure spilled on the soil surface at the ends of the runs

## TRACTOR-PULLED FLEXIBLE HOSE WITH BROADCASTING

Although this system is not widely used in Ontario, it is worthy of mention. Instead of the manure being injected into the soil, it is broadcast onto the soil surface. The tractor mounted unit simply consists of a pipe, nozzle and deflector plate. It gives the same spread pattern as many of the tank spreader broadcast systems, but without the travel time to and from the storage, and with less soil compaction. Two Huron County farmers designed and built one such system to suit their farming needs. To the author's knowledge, no other systems are commercially available in Ontario. However, if the idea catches on it will likely be popular with farmers who want to build their

own.

**Advantages**

- simple design and operation
- relatively inexpensive
- relatively low power requirements to pull hose

**Disadvantages**

- odor levels can be high
- uniform application is difficult during gusty or very windy conditions
- manure nutrients are lost if manure is not immediately worked into the soil

A combination of this system and the soft-hose travelling gun irrigation system is commercially available. Instead of a nozzle and deflector plate, an irrigation gun is mounted on the tractor. It is fed by the dragging flexible hose, and by moving back and forth in a semi-circular pattern, can cover a greater spread width per pass.

## CUSTOM SPREADING

Many custom operators are available to spread liquid manure. Their services are in great demand, at least during certain times of the year. A wide variety of equipment is used by custom operators. The larger operators can justify the cost of more elaborate equipment than what most farmers would buy. Hence, we see tank spreaders mounted on trucks which are fast and often have high flotation tires. Not only is travel time cut down, but compaction isn't as severe as with tractors and tank spreaders.

Custom manure irrigators use large hard hose travelling gun systems. Many farmers view manure spreading as a very unsavory job that is costly and time-consuming, so to have someone else do the job for them is most welcome, as long as the cost isn't out of line. Cost will depend on the expenses which the operator incurs. They will tend to be lower in areas of strong competition for jobs. Some operators have complicated formulas for determining cost. These may include a flat rate for setup, and either an hourly charge or a charge based on the volume spread. Agitation of manure often must be handled by the farmer.

**Advantages**

- little or no labor supplied by the farmer
- often the custom operator can spread faster and more evenly because of size and design of equipment
- often the cost is less than if the farmer spreads the manure with his own equipment

**Disadvantages**

- timing of spreading is usually not under the farmer's control
- employees of custom operators may not be as conscientious as farmer would like

## GENERAL

1. Used properly, liquid manure can be a real asset in crop production. Problems have occurred due to poor spreading practices. Plugged drain tiles and pollution of streams have resulted. Over-application of manure and spreading of manure on wet land are the worst culprits. Some spreading systems (especially irrigation systems) allow the farmer to apply manure to land that is too saturated to receive it. Wait until the field is dry enough to work the manure into the soil before spreading.

2. Nutrient retention and odor control go hand in hand when it comes to manure spreading. If the manure is worked into the soil within 24 hours of spreading, the most nutrients are retained and odor is minimized. Table 1 gives a comparison based on measured losses of ammonium-nitrogen.

**Table 1. Ammonium-nitrogen Losses to the Air**

| Method of Application | Type of Manure | Nitrogen Lost* % |
|---|---|---|
| Broadcast | Solid | 21 |
| | Liquid | 27 |
| Broadcast with immediate cultivation | Solid | 5 |
| | Liquid | 5 |
| Knifing (injection) | Liquid | 5 |
| Sprinkler Irrigation | Liquid | 30 |

**of the nitrogen present in the manure at the time of application, the table lists the % lost within 4 days of application.*

3. In a great many cases, pumps play an integral part in the total "spreading system". As mentioned, the vacuum tank spreaders have their own air pumps and do not necessarily require the use of extra pumps. Gravity loading systems also do not need pumps. By far the majority of spreading systems use pumps. They are used to agitate and pump, or just to pump manure. In general, when manure is moved long distances through rigid pipe to an irrigation system or other system, the pressure (or head) that the pump can achieve is the important consideration. Usually these pumps are chosen for high head and may have relatively low capacities. On the other hand, a pump used to agitate a storage and fill a spreader needs a high capacity. Head is not nearly as important.

4. The capacity (volume spread per hour) of different systems can vary widely. The three factors which influence this most are: equipment design, application rate, and distance from the manure storage to the field. Tank spreader systems are especially influenced by distance to the field. As the travel time increases, the volume spread per hour decreases. In an on-farm study of tank spreader and irrigation systems carried out recently in Huron County, spreading rates for tank spreaders were found to range from 16000 l/hr (3500 gal/hr) to 77000 l/hr (17000 gal/hr) with the average value around 38000 l/hr (8400 gal/hr). Injection systems averaged slightly lower rates than the broadcast systems (about 10% less). Irrigation systems with hard-hose travellers averaged about 45000 l/hr (10,000 gal/hr).

The tractor-pulled flexible hose systems with injection or broadcasting have a higher ratio of actual operating time to "down time" (time not actually spreading). They are capable of spreading rates in the order of 90000 l/hr (20,000 gal/hr) or more.

There are many things to consider when choosing a system of spreading liquid manure. With the range of capacities and designs of equipment on the market today, the choice is often a tough one. By carefully assessing the needs and limitations of the farming operation, the livestock farmer is on the right track toward choosing the right spreading system for that farm.